

As prepared for delivery

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Thank you, Stephen [Ganote] for that kind introduction.

Great way to begin the New Year – with you who have helped us accomplish so much... and who are going to be such a big part of our future.

Your companies have been indispensable to NASA's extraordinary accomplishments over the past 50 years -- from landing a man on the moon to landing the most sophisticated rover ever on Mars – you are also indispensable as we usher in the space program for the 21<sup>st</sup> century that will be marked by even greater levels of innovation and partnerships...and more and stronger public-private collaborations. The history of exploration is rich with examples of such successful collaborations and I'm going to talk about one of those today... but first I do want to give a brief overview of some of our recent accomplishments from the video that were made possible by so many of you and talk a little bit about what's in store for the coming year.

As you know, in August, we completed the most challenging mission in the history of robotic planetary exploration with the landing of Curiosity on the surface of Mars. Carrying the highest-powered scientific capability of anything ever sent to the surface of another planet, this robotic laboratory is now seeking answers to one of humanity's oldest questions as it investigates whether conditions have favored development of microbial life on the Red Planet.

We also achieved a huge milestone last year with the first successful commercial resupply mission to the station, launching once again from American soil. And our industry partners made strong progress toward the eventual capability of launching humans on commercial rockets.

On October 28<sup>th</sup>, SpaceX's Dragon spacecraft successfully resupplied the International Space Station and returned cargo back to Earth; completing NASA's first contracted cargo delivery flight. This not only demonstrated technical capability, it validated the policy direction we are pursuing relying on American ingenuity to send cargo and crews to Station, while we focus on the more challenging missions in deep space.

Under NASA's Commercial Resupply Services contract, SpaceX will fly at least 12 cargo missions to the space station through 2016. This is the only system capable of returning considerable amounts of research and samples for analysis from the ISS – so its success is extremely welcome. Let's be clear – ISS is the centerpiece of our human spaceflight program.

SpaceX is one of two companies that built and tested new cargo spacecraft under NASA's Commercial Orbital Transportation Services (COTS) program. Orbital Sciences is the other company participating in COTS. Orbital's Antares launch vehicle is on the launch pad at Wallops Flight Facility in Virginia in advance of a hot fire test of the Antares first-stage engines. A flight test of the Antares with a simulated Cygnus spacecraft and a demonstration flight of Cygnus to the space station are planned for 2013.

With commercial cargo flights to the space station under way in 2012, we've taken the next steps in the effort to launch Americans from U.S. soil again with the CCoCap awards that we announced in August to three commercial companies – Boeing, Sierra Nevada and SpaceX -- to design and develop the next generation of U.S. human spaceflight capabilities, enabling a launch of astronauts from the United States to the ISS by the middle of the decade.

And we're going back to Mars this year...the MAVEN mission that will study the Martian atmosphere was built by Lockheed Martin and is currently being tested in their facilities in Denver. We just announced another rover mission to Mars in 2020. And last July, NASA's Kennedy Space Center in Florida welcomed the arrival of the agency's first space-bound Orion capsule, marking a major milestone in the construction of the spacecraft (also built by prime contractor Lockheed Martin) that will carry astronauts farther into space than ever before.

The Orion capsule that is at Kennedy will launch on Exploration Flight Test-1, an uncrewed mission planned for 2014.

NASA and its prime industry partners, Boeing, ATK and Pratt Whitney, also made swift progress on the Space Launch System (SLS) last year, testing and developing new components and improving on existing hardware, leading to our planned first test flight in 2017, which will take us back around the Moon.

We are also advancing cutting edge science missions, including steady progress with our lead contractor, Northrop Grumman on the development of the **James Webb Space Telescope**. Scheduled for a 2018 launch on an Ariane launch vehicle, the JWST will be the most powerful space telescope ever built and will allow us to study every phase in the history of our Universe.

Our aeronautics program is collaborating with other government agencies and private sector partners to advance the state of the art in aviation, with the goal of helping to make air travel safer, greener and more efficient (Next Gen).

With more than 60 operational missions, our science portfolio is yielding streams of data from orbits around the Sun, Mercury, the Moon, Mars, and Saturn. We now have missions on the way to Jupiter, Pluto and the dwarf planet, Ceres. We work with private sector contractors on every one of these missions – something we can all be proud of.

And proud we are... late last year the results of a government-wide employee survey were announced and NASA was rated the number one

place to work in the entire federal government. It was an honor to represent NASA at several events – and accept this award on behalf of employees, but it has really caused me to think about what is behind this success. (We have been focusing on workforce issues, training, communications, “leadership” and I’m sure a lot of things have helped play a role.)

But I can’t help think there is a deeper reason people enjoy their jobs at NASA – and hopefully in the contractor community too...

What we do at NASA is important, makes a difference and... let’s face it, can be exciting and fun.

What is it about “exploration”, “innovation”, “discover” that makes us feel just a little bit better about coming to work every day? What we do and discover has real down-to-Earth implications for people, for our environment and for our economy.

The NASA vision statement is clear: Our real goal is “To Reach for New Heights and Explore the Unknown so that what we do and learn will benefit all Humankind.” We do NEW things... that advance benefits for humanity...

Our guiding documents lay out our purposes (’58 Space Act, ’10 Auth Act, National Space Policy)...

- 1) Advance human knowledge...
- 2) Increase US competitiveness...

3) Lead/preeminence

4) Cooperate with other nations

Wikipedia describes exploration as: “the act of searching or traveling around a terrain (including space) for the purpose of discovery of resources or information”... “its peak, arguably during the “age of discovery” (15<sup>th</sup>-17<sup>th</sup> century)... when Europeans “explored” for trade routes for gold, silver and spices...”

So we at NASA -- and you, our industry partners, in many ways are the bearers of the flame of exploration and discovery.

I think for a lot of us, that makes us feel pretty good about the work that we do. But as the definition of exploration states – it is not exploration for exploration’s sake – or for the “fun” of the explorer – it is “for the purpose of discovery of resources or information”. So let’s take an example from the “peak” of exploration – from the Age of Discovery. I came across a fascinating book over the holidays that outlines just such an historic example. The book, called “Longitude, by Dava Sobel, is “The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time.” It describes the centuries-long quest to solve the problem of determining longitude. The quest, as many of you are probably aware, was not as an isolated scientific exercise – but as a way to prevent the loss of life and precious cargo due to the inability to accurately chart a ship’s east-west direction on the high seas. As the book describes it, “For lack of a practical method of determining longitude, every great captain in the Age of

Exploration became lost at sea despite the best available charts and compasses. From Vasco da Gama to Vasco Nunez de Balboa, from Ferdinand Magellan to Sir Francis Drake – they all got where they were going willy-nilly, by forces attributed to good luck or the grace of God.”

The 1707 crash of Admiral Sir Cloudisley’s English fleet into the jagged rocks of the Scilly Isles resulted in the loss of nearly two thousand lives and, “precipitated the famed Longitude Act of 1714 in which Parliament promised a prize of 20,000 pounds (which would be millions of dollars today) for a solution to the longitude problem.”

This story has so many analogies and lessons for us today, but let’s start with the very purpose of the search for a way to determine longitude... The search had been on for centuries... one hundred years earlier, King Charles the II had established the Observatory at Greenwich and appointed the very first “astronomer royal” to apply “the most exact care and diligence to rectifying the Tables of the Motions of the Heavens, and the Places of the fixed Stars, so as to find out the so-much desired Longitude at Sea, for perfecting the art of navigation”. To further make the point, the book’s author, Sobel states, “Thus, the founding philosophy of the Royal Observatory, like that of the Paris Observatory before it, viewed astronomy as a means to an end. All the far-flung stars must be catalogued, so as to chart a course for sailors over the oceans of the Earth.”

So the purpose of the search was not science for science sake, but rather science for advancing real benefits to the public.

So how did the government (the King) determine was the best way to advance this most important of discoveries? By establishing a Prize. When the Longitude Act was established in 1714, it created a blue ribbon panel of judges that became known as the Board of Longitude. The Board, which consisted of scientists, naval officers and government officials could give incentive awards to help impoverished inventors bring promising ideas to fruition and the author identifies the Board as the first official research and development agency. Even 300 years ago, it was recognized that innovation and technology could be fomented in a wide variety of ways... (early “crowd sourcing”?)

Finally, after years of attempts by numerous prominent astronomers, an unschooled carpenter and clockmaker named John Harrison solved the problem with his invention of the first marine chronometer (a precise clock).

It should not be surprising, that the forward to “Longitude” was written by Neil Armstrong. Neil often credited the “longitude prize” as a critical step along the way to our ultimate ability to navigate our way to the Moon...

This story has so many analogies and lessons for us today, but this starts with this very purpose of the search and with the decision to offer a Prize, instead of paying more money to just the scientists and inventors of the day.

This history reminds us that NASA’s focus on driving innovation in exploration and discovery is not new and that part of our driving purpose is to return the many real benefits from these programs to those of us on Earth.



Specific examples include: NASA's fleet of Heliophysics research spacecraft that monitor the sun and its impacts on Earth and the solar system. Changing conditions on the sun – or space weather – can interfere with the reliability of technologies located in space, such as communications and global positioning satellites and on the ground, such as electric power grids. Radiation from space weather can also pose a danger to astronauts and spacecraft.

Our Aquarius satellite, launched in 2011, is for the first time, mapping the salinity of Earth's oceans and monitoring the effects of ocean salinity on our climate.

SERVIR, a joint venture between NASA and the U.S. Agency for International Development (USAID), is providing satellite-based Earth observation data and science applications to help developing nations in Central America, East Africa, and the Himalayas improve their environmental decision making. SERVIR — an acronym meaning “to serve” in Spanish — provides this critical information to help countries assess environmental threats and respond to and assess damage from natural disasters.

NASA's Space Technology Program has initiated two demonstrations that will take advantage of the commercial hosting of payloads as one of NASA's first forays into such an approach. One will validate valuable laser communications-related concepts and one will study a high accuracy, long life atomic clock that will help improve precision navigation and timing of our next deep space explorers. Leveraging existing commercial spacecraft accommodations and launch services contracts for hosted payloads

provides unique opportunities for achieving proofs-of-concept with minimal cost and schedule demands. (hosted payloads – the food trucks of satellites...)

We are currently evaluating proposals for Flight Opportunities for people interested in flying experiments on our commercial partners' suborbital rides – NASA's providing the ability to American universities, businesses and research institutions to test new technologies in near-space.

We're also continuing to work with prizes and incentives such as the Centennial Challenges. The next Sample Return Robot Challenge, for example, will be in June 2013 of this year with Worcester Polytechnic Institute.

We just closed applications for the next class of Space Technology Research Fellowships for graduate students – and just completed the latest round of Small Business Innovation Research and Small Business Technology Transfer proposals, research and development opportunities to help us create the new technologies needed to enable the agency's future missions while benefiting America. Awards will be made next month.

The Space Technology Program is engaging with more than 350 Universities and academic institutions through fellowships, direct competitive awards and partnerships with NASA Centers and commercial contractors for its technology developments and demonstrations.

NASA has a long history of transferring its technologies for public benefit. The evidence is all around us: Knowledge provided by weather and navigational spacecraft; efficiency in ground and air transportation; super computers; solar- and wind-generated energy; biomedical technologies and the protective gear that keeps our military, firefighters, and police safe have all benefitted from the nation's investments in aerospace technology.

These technologies have found second uses after their NASA missions, saving tens of thousands of lives, creating tens of thousands of jobs, reducing billions of dollars in cost, and generating billions of dollars in revenue.

Each year NASA records these benefits in its annual *Spinoff* publication. We've recorded over 1800 to date since we started this annual report in 1976. While by no means the total number of NASA spinoffs, this represents some of the best examples of American ingenuity -- taking the technologies developed for space and turning them into new applications. This year's report, currently being printed, features fifty new examples, including:

A robot assistant now roaming the halls of hospitals around the country, helping with everything from registering patients to logging vital signs. The robot has been dubbed "a Mars rover in a hospital" by one of its developers, who employed the expertise he gained working on Mars robotics for NASA to create the technology. The robot is not only easing the

workload of hospital staff but also providing an economic return, creating 20 new jobs for its manufacturer.

An invisible coating, developed by a NASA Dual-Use Technology partner and tested at NASA facilities, is capable of breaking down pollutants, eliminating odors, and inhibiting the buildup of grime. The technology's many applications include enhancing the efficiency of solar cells, sanitizing air in the homes of those suffering from cystic fibrosis, and even transforming buildings and towering modern art sculptures into massive air purifiers.

A solar energy system able to provide about 200 times more power than conventional panels benefited from innovations developed through an SBIR partnership. The company founded to commercialize these NASA-derived sustainable energy installations now employs 30 workers, all with a mission to move renewable solar power into true mainstream use.

Even before it launches the James Webb Space Telescope is already yielding spinoffs in health and medicine and industrial productivity. Innovations designed to perfect the telescope's massive mirrors, for instance, have been incorporated into technology for mapping the eye and diagnosing sight-threatening conditions.

Again – the tale of the search to determine Longitude offered an early example of investing in one area of discovery, only to find others...as the book outlines...

“In the course of their struggle to find Longitude, scientists struck upon other discoveries that changed their view of the universe. These include the first accurate determinations of the weight of the Earth, the distance to the stars and the speed of light.”

Another interesting and possibly analogous aspect of the Longitude story pits scientists against engineers. The astronomers believed the solution was “in the stars”... charting more and more precise maps of celestial movements. While the engineers worked tirelessly in their laboratories building more precise engineering solutions – clocks.

Decade long battles between these groups and specific rival individuals shape the story. For any of us who are appalled or fascinated by the crassness of modern-day corporate and political warfare – This too, is not a new tale. At one point, an astronomer vying for the Prize secretly agrees to split the purse with the Chair of the Longitude Board if he wins. So When Harrison’s chronometer returns from his first voyage more than successful according to the established rules, the Board Chair “moves the goalposts...” he sets new, more strict rules and requires two more voyages, in hopes of allowing the astronomers “mapping” solution to gain the Prize first.

It is only after over 40 years of “political intrigue, international warfare, academic backbiting, scientific revolution and economic upheaval.” That Harrison is fully awarded the Prize. It is worth noting that while Harrison wins the Prize, the ultimate success required both the chronometer AND

more accurate star-maps (the scientists and engineers needed to work together).

We like to think we live in unique times. That we are the very first to experience what it is that we are going through. And yes, we are facing new challenges – tight budgets and problems face our nation and our planet.

But exploration and discovery have always advanced our society during difficult times. Innovation and technology advancement have always returned great economic and public benefit. Now is no different. All we need to do is keep proving that NASA and our partners in industry are up to the challenge. By focusing on returning greater economic and public benefit is in fact how we have always justified our public spending on exploration and discovery. It is, I think, one of the key reasons so many of us do enjoy and gain satisfaction from what we do (according to the survey).

We know we don't have the luxury today of spending taxpayer dollars on a fun adventure with no economic return. This story reminds us, that maybe we never did. The truth is that exploration and discovery are done specifically for the benefit of humankind – that is why we have always reached beyond our grasp and why we keep doing it today.

Thank you.